

METHOD AND DEVICE FOR ACTIVATING AN ELECTRIC PARKING BRAKE

The present invention relates to a method and a device for activating an electric parking brake of a motor vehicle, in particular a road motor vehicle.

5 From DE 198 38 886 A1 an electric immobilizing brake or parking brake for a vehicle is known. The driver of the motor vehicle activates the electric parking brake via a push-button switch, for example. The parking brake ensures that the vehicle is no longer able to move in the stopped or parked
10 state. To achieve the immobilizing braking effect, it is possible, for instance, to control the parking brake's wheel brakes situated on the wheels of the motor vehicle by electromotor/transmission units designed to self-lock. This realizes the effect of a conventional mechanical
15 immobilization brake.

Activation of the electric parking brake requires electric energy, which can be drawn from the vehicle electrical system. When turning off or parking the motor vehicle, in particular
20 on inclines, it is important that the electrical energy is available at all times. Otherwise it may happen that the vehicle is not reliably protected from unintended rolling. Dangerous situations may occur as a result, in particular in motor vehicles in which the mechanical power of the drive
25 motor is additionally utilized to activate a service brake of the motor vehicle. If after shut-down of the drive motor the electrical energy in such vehicles is no longer sufficient to restart the drive motor, the vehicle is no longer fully controllable.

30 To avoid such situations, DE 198 38 886 A1 proposed to provide an auxiliary battery whose energy, as a minimum, is sufficient

to activate the parking brake. Disadvantageous in an auxiliary battery provided in addition to the battery of the vehicle electrical system is the effort and expense it entails with regard to construction and production. Also, it is possible once again that the auxiliary battery will no longer have sufficient energy or is unable to store sufficient energy.

It is an object of the present invention to provide a method and a device for activating an electric parking brake of a motor vehicle, which allow reliable stopping of the motor vehicle during parking.

The subject matters of the independent Claims 1 and 6 constitute achievements of this objective. Advantageous further developments are indicated in the respective dependent claims.

According to an essential idea of the present invention, a drive motor of the motor vehicle is to be turned off only after activation of the electric parking brake when parking the motor vehicle. In this way the mechanical energy of the drive motor may still be used for the activation, in particular by the drive motor driving a generator and using for the activation the electrical energy produced by the generator. This allows the motor vehicle to be parked securely even when the energy store of the vehicle electrical system is low.

It is expediently detected that the shut-down operation is initiated, and the parking brake is activated subsequently. For instance, it is possible to monitor whether the vehicle driver gives a signal for turning off an ignition system of an internal combustion engine. The turn-off is implemented only when the parking brake is activated.

In particular when a generator mechanically coupled to the drive motor is used to generate electrical energy, no modifications with respect to conventional electrical wiring systems of motor vehicles will be required. Specifically, no auxiliary battery is necessary to activate the electric parking brake. Instead, the present invention may be realized solely by appropriate design of the control devices in the motor vehicle.

A device for activating the electric parking brake has, for instance, an activation device for generating an activation signal that activates the electric parking brake. According to the present invention, the activation device may, in particular, generate the activation signal automatically, especially when the motor vehicle is being parked. To this end, a detection device for detecting the initiation of the parking operation is provided. In a development of the detection device, it detects the initiation of a shut-down operation for turning the drive motor off. If a conventional ignition lock with ignition key is provided, for example, the vehicle driver turns the ignition key to the "off" position in order to shut down the drive motor. However, the vehicle driver may also give a signal for shutting down the drive motor in some other manner, for instance by activating an electric push-button switch.

Furthermore, an engine-control device for controlling the shut-down operation is provided in the device. The detection device is connected to the engine-control device and to the activation device. The activation device and the engine control device are designed and combined with each other in such a way that, once of the shut-down operation has been initiated, the activation signal activates the electric parking brake first, the operation of the drive motor being

maintained in the meantime, and the drive motor being turned off only afterwards.

It is possible to provide a higher-level control device, which controls the sequence of actions of the engine-control device and the activation device. This higher-level control device may also assume additional tasks such as detecting the initiation of the shut-down operation (i.e., it includes the detection device) and/or additional determinations and/or detections, which will be addressed in more detail later on and on the basis of whose results a decision is made as to whether the drive motor will be utilized to activate the electric parking brake.

The engine-control device, the activation device and/or the detection device may also be integrated in a shared control device. This case is encompassed by the wording that the devices are interconnected.

Although it is possible to shut down the drive motor during each parking operation only after the parking brake has been activated, it is preferred that this be made dependent on one or more of the following criteria:

- The operating state of an electrical energy supply of the motor vehicle. In particular, a loading state of an energy store of the energy supply is ascertained and/or it is determined whether the energy store is defective. To this end, an operating-state device for determining the operating state may be provided in the aforementioned device, the operating-state device being coupled to the engine-control device.

- An angle of inclination of the motor vehicle. This criterion is considered satisfied, for instance, when the amount of the angle of inclination is greater than or equal to 8° . With respect to the angle of inclination it may be differentiated between the roll angle (measured in a plane transversely to the vehicle's longitudinal axis) and the pitch angle (measured in a plane that includes the vehicle's longitudinal axis). Preferably, solely the pitch angle is considered in the decision as to whether the method according to the present invention will be implemented. A detection device for ascertaining the angle of inclination may be provided in the aforementioned device, the detection device being coupled to the engine-control device.

- Standstill of the motor vehicle. In particular, it is determined whether all wheels of the motor vehicle are stopped. Signals from rpm sensors, for example, may be analyzed for this purpose. Rpm sensors have the advantage of normally being present in motor vehicles anyway, for instance in connection with an anti-lock braking system.

25 The automatic activation of the parking brake with a subsequent shut-down of the drive motor may thus be made dependent on whether the operating state of the electric energy supply requires it, whether the motor vehicle is to be parked at an angle of inclination that is greater than a minimum angle of inclination, and/or whether the vehicle is at a standstill. In this way the present invention carries out its safety function only when required, and the functionality is not conceived as distracting. After parking on level terrain, for example, the motor vehicle is thus able to be moved without renewed startup of the drive motor.

The activation of the electric parking brake according to the present invention may be implemented in a variety of ways.

For instance, the operation of the drive motor may be

5 maintained for a period of time having a defined length and starting with the initiation of the shut-down operation and/or the receipt of a corresponding shut-down signal for turning the drive motor off. As an alternative, it is possible, for instance, to first determine whether the parking brake was
10 activated and only then to generate a signal that effects the shut-down of the drive motor. With the first option, it has been shown to be sufficient to maintain the operation of the drive motor over a period of time that lasts at least one second.

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The present invention is elucidated in the following on the basis of a preferred exemplary embodiment.

The figures show:

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Fig. 1 a schematic representation of a system in a road motor vehicle having an electrical energy supply and including control devices that allow an implementation of the method according to the
25 present invention; and

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Fig. 2 a time diagram in simplified form, which shows the chronology of different actions and events in the execution of the method according to the present
30 invention.

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Motor vehicle 1, schematically shown in Fig. 1 within a rectangular frame, has a drive motor 3, which during its operation drives a generator 6 via a mechanical coupling 4.

35 The electrical energy generated by generator 6 is fed into a

vehicle electrical system 5, which has at least one energy store for storing electrical energy, in particular a conventional vehicle battery. Vehicle electrical system 5 is connected to a battery state device 8 (such as a control device for a vehicle electrical system), which is able to determine a charge state of energy store 7, in particular. A corresponding result of this determination is transmitted to a control device 14 of an electric parking brake (EPB control device in the following text), continuously and/or as required.

Drive motor 3 in the exemplary embodiment is an internal combustion engine, which can be turned off and on by activating an ignition switch 12. Ignition switch 12 is connected to an engine control device 10, which in turn is connected to drive motor 3. In this way engine control device 10 is able to actually take the switching state of ignition switch 12 into account, but not implement a corresponding action directly (i.e., without a time delay). Instead, engine control device 10 may maintain the operation of drive motor 3 as a function of signals it receives from EPB control device 14, notwithstanding the fact that the ignition switch was turned to the "off" position. It is also possible that engine control device 10 decides on its own whether and/or for how long the operation of drive motor 3 will be maintained.

A separate rpm sensor 15 is shown in the region of the four corners of the rectangular frame in Fig. 1, which is assigned to one of the four wheels of motor vehicle 1 in each case. In this way a movement device 16 (which has a wheel speed evaluator, in particular) is able to record the rotational wheel speeds of all four wheels. Movement device 16, in particular, is able to determine whether all four wheels -- and thus vehicle 1 -- are/is at a standstill. Movement device 16 is connected to EPB control device 14, so that EPB control

device 14 receives a signal from movement device 16,
continually and/or as required, and it is possible to
determine from the signal whether the vehicle is stopped.

5 Furthermore, a detection device 18 is provided, which
ascertains an angle of inclination of motor vehicle 1,
preferably the amount of a pitch angle. A corresponding
signal is transmitted to EPB control device 14 on a continuous
basis and/or as required.

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An example of an operation of the system shown in Fig. 1 will
now be explained in greater detail with reference to Fig. 2.

First of all, it is assumed that energy store 7 of vehicle
15 electrical system 5 is in a fully functional operating state,
i.e., in particular is sufficiently charged to activate an
electric parking brake, which is not shown further in Fig. 1.
The activation, with the aid of electrical energy from the
vehicle electrical system, may be carried out as described in
20 DE 198 38 886 A1, for example, whereas the generation of a
corresponding activation signal is implemented in the manner
of the present invention.

If ignition switch 12 is switched to "off", EPB control device
25 14 determines from the signals received from operating state
device 8 that energy store 7 carries a sufficient charge. By
transmitting a corresponding control signal to engine control
device 10 (or by non-transmission of a control signal), engine
control device 10 determines that operation of drive motor 3
30 is able to be terminated immediately, and turns drive motor 3
off.

Accordingly, drive motor 3 is also shut down immediately once
ignition switch 12 has been switched off if detection device

18 determines that a predefined amount of an angle of inclination (such as 5° or 8°, for instance) is not exceeded.

In an especially preferred specific embodiment, if ignition switch 12 is switched off and motor vehicle 1 is not at a standstill, EPB control device 14 outputs a corresponding signal to engine control device 10, so that the operation of drive motor 3 will not be terminated (and the electric parking brake will not be activated either) until vehicle 1 is stopped. The method according to the present invention may be implemented in the manner described in the following text as soon as standstill has been reached.

If vehicle electrical system control device 8 detects that the operating state of energy store 7 does not allow reliable activation of the electric parking brake (for instance, that the energy store is defective), if detection device 18 detects that motor vehicle 1 is on steep terrain (the amount of the pitch angle is greater than 5° or 8°, for example), and if vehicle 1 is stopped, the following actions will be carried out:

When turning ignition switch 12 off at instant t_0 (illustrated in Fig. 2 as abrupt decrease in signal 1 from a high level to a low level), EPB control device 14 detects the described state of motor vehicle 1 and outputs a signal to engine control device 10, which induces it not yet to terminate the operation of drive motor 3. This is illustrated in Fig. 2 by a horizontally extending line M, which continues past instant t_0 at a high level. At the same time or subsequently, EPB control device 14 outputs a signal to an activation device (not shown further) for activation of the electric parking brake, so that the electric parking brake is activated beginning with instant t_1 and is fully activated at instant t_2 . This is illustrated in Fig. 2 by a line B, which rises

from instant t_1 to instant t_2 . The electric parking brake then stays in the activated (engaged) state. A time span that corresponds to the interval between instant t_0 and instant t_3 at which engine control device 10 initiates the switch-off of drive motor 3 is predefined in engine control device 10 (for instance, programmed). As indicated in Fig. 2 by a descending line M between instant t_3 and instant t_4 , drive motor 3 is turned off only after the interval has elapsed. The interval is preferably selected to be greater than the maximally possible duration of the activation of the electric parking brake, plus possible intervals that are required to carry out the described control measures. For instance, as shown in Fig. 2, a short delay occurs until the activation of the electric parking brake begins at instant t_0 after ignition switch 12 has been turned off.

As an alternative, the activation device outputs a success signal to EPB control device 14 once the electric parking brake is fully activated.

Variants and further developments of the method according to the present invention and the device according to the present invention are possible. For instance, a deactivation device may be provided, which is able to prevent the execution of the method according to the present invention and/or which is able to deactivate (disengage) the already activated electric parking brake without renewed starting of the drive motor. In this way it is possible, for instance, to tow the motor vehicle even on steep terrain. The deactivation device is directly connected to EPB control device 14, for instance, which controls the operation of the electric parking brake accordingly.